LETTERS TO THE EDITOR.

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Physical Measurement of Public Schoolboys.

I ENCLOSE photographs of two lecture diagrams which were used for a paper on the physical development of public schoolboys read to the Medical Officers of Schools Association last Easter. The curves represent the various different schemes of growth followed by schoolboys from the age of $10\frac{1}{2}$ to $18\frac{1}{2}$, according as they are developing into large, small, or medium sized men. They are constructed from corresponding series of curves of distribution, which curves are constructed from a large number of observations recorded at various public schools. From 14,000 to 15,000 observations have been collated for the construction of each series, and I regard them as being fairly

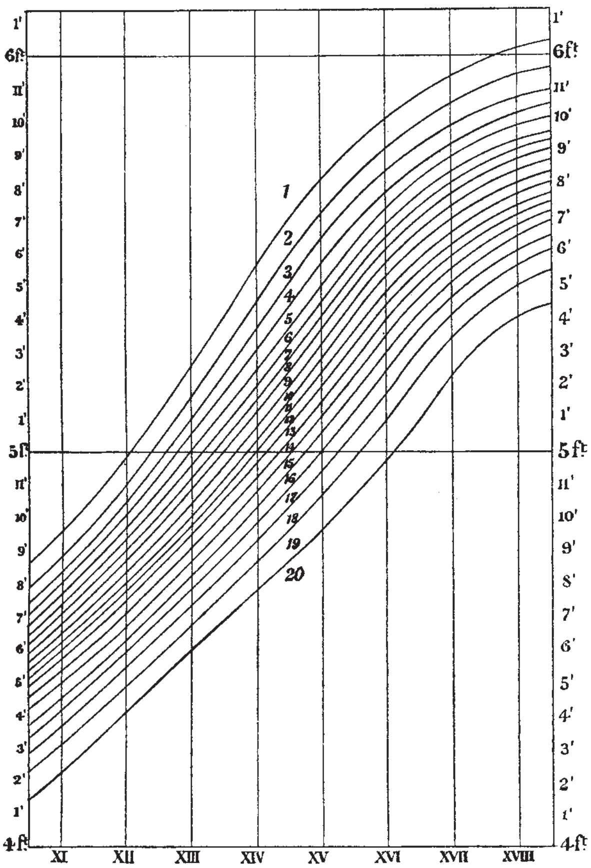

FIG. 1.—Grade curves for height of public schoolboys from $10\frac{1}{2}$ to $18\frac{1}{2}$ years of age. The figures on the base line refer to age. The figures down the centre of the diagram are the numbers of the grades, which are bounded by the two curves between which the several numbers are placed. There is no lower limit to grade 20, nor upper limit to grade 1.

trustworthy in form between the ages of 12 and 18. Beyond these limits the form of the curves may be slightly at fault, owing both to insufficient number of observations and to the process of natural selection which influences the physical status of the majority of boys who come early and stay late at a public school. The curves in Fig. 1 are constructed by marking off on the vertical line through each age the various heights at which the curve of distribution for that age crosses the 5 per cent., 10 per cent., 15 per cent., . . . 95 per cent. lines. Each series of corresponding points is then joined up by a flowing curve, with the result shown. The central line, between the numbers 10 and 11, shows where the various curves of distribution cross the 50 per cent. line, and consequently indicates the scheme of growth of the mean boy.

It was contended in the paper that since each of these curves represents the growth of a boy, who develops in such a manner as to preserve always the same relative position amongst his fellows, they give an accurate idea of the growth which may be reasonably expected from a boy at any stage of his development, whatever his physical status may be. A glance at the diagram will show that the rate of growth, which is measured by the pitch of the curves, varies considerably for boys of the same age but of different physique. The period of maximum growth is reached much sooner by a boy of a high grade than by one of a low grade, and lasts much longer. Thus the steepest pitch of the topmost curve occurs between the ages of $13\frac{1}{2}$ and $14\frac{1}{2}$, and is sensibly uniform during that period, the corresponding steepest pitch in the mean line lies between the ages of 15 and $15\frac{1}{2}$, in the lowest line it lies between $16\frac{1}{2}$ and 17. Consequently, during the period of fastest growth, all boys may be expected to grow at nearly the same rate; but this rate of growth is reached by some boys three or four years later than by others.

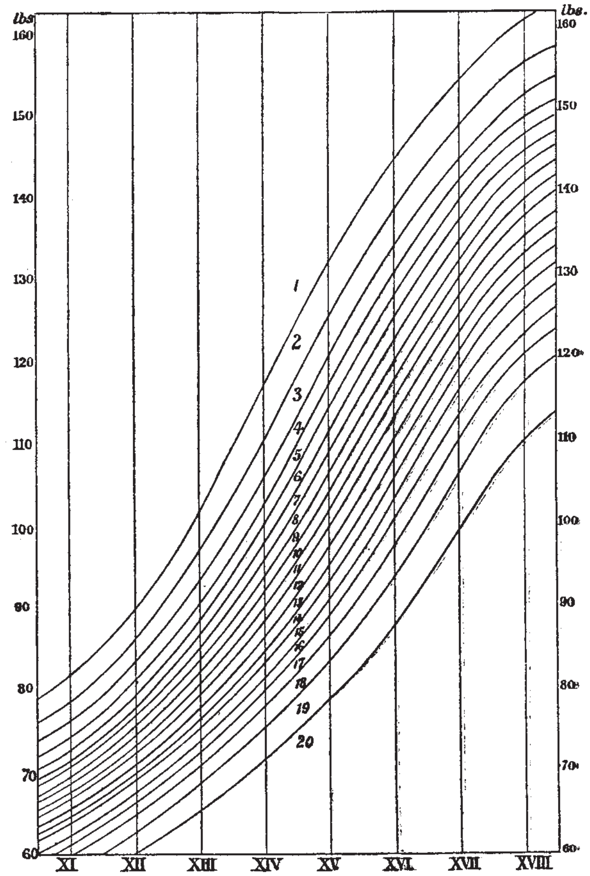

FIG. 2.—Similar grade curves for weight.

Fig. 2 represents the corresponding series of curves for weight, and teaches much the same lessons; it is evident, however, that the rate of growth in height declines much more rapidly after the period of maximum growth is passed than the rate of growth in weight, consequently boys of the same height but of different ages may be expected to differ considerably in weight. That this is generally the case was clearly shown by another set of curves exhibited at the lecture.

The curves shown have been used for constructing tables of grades, by means of which the limits of twenty grades are fixed, in some one of which a boy can be immediately placed if his measurements are known. From the mode of construction it is evident that, *a priori*, each of these grades is equally probable. The tables have in actual practice been found to be of great use in estimating the progress of individuals, and of gymnastic

classes, &c. Thus an analysis of the grades of chest-girth of 255 boys before and after a three terms' course of compulsory gymnastics showed that the following improvement had been made. The numbers in the lower line give the percentage of the boys examined, who made the number of grades improvement indicated in the line above.

Improvement :—										
1 gr.	2 gr.	3 gr.	4 gr.	5 gr.	6 gr.	7 gr.	8 gr.	9 gr.	10 gr.	11 gr.
Per cent. :—										
11	11	12	10	7	6	4	4	1	4	1

This with the omitted fractions gave 73 per cent. of the boys who had made more or less marked improvement relative to the general mass of boys of their age, the improvement in some cases being very marked indeed.

An analysis of the growth of 161 boys by means of their grades showed that the scheme of growth corresponded to the scheme indicated by the curves in the diagram in 31 per cent. of the cases examined. There was a steady rise relative to this standard in 17 per cent.; a steady fall in 10 per cent.; a period of rise followed by one of fall, or *vice versâ*, in 18 per cent. In 9 per cent. the variation was erratic, and the remaining 15 per cent. probably belonged to the first group; but not within the limits of variation allowed.

In 68 per cent. the type of structure, as indicated by the relation of height to weight, was stable throughout the period examined; but in about one-fourth of these cases there was a considerable constant difference between the grades of height and weight, amounting in the most extreme cases to as much as eight grades.

The lesson drawn from these observations was that, in order to form a correct opinion relative to a boy's physical progress by means of his measurements, it is very desirable to keep a regular record of his growth, in order that the general scheme of his growth may be determined, and that any irregular fluctuations due to external and removable causes may be noted and properly dealt with. C. H.

The Giant Tortoises of the Galapagos.

I NOTICED in your issue of June 15 a paragraph about the Galapagos tortoises. I do not know if this information is of any interest, but during my residence in Hawaii I knew of two living there. One of them lived in a garden near Hilo, and belonged to the late Captain Thomas Spencer; I last saw it about 1880. The other one lived on the Waimea plains in a perfectly wild state, and I used frequently to come across it when out shooting. It used to wander about within a radius of three or four miles.

It was blind of one eye, and its shell had lichen growing on it, and it could move about with a man sitting on its back.

I last saw it in 1890, but it may possibly be still living; this, however, could easily be ascertained.

They were, I believe, brought to Hawaii from the Galapagos in whalers, and were of great age. If desired, I shall endeavour to find out if they are still alive. W. HERBERT PURVIS.

10 Alexandra Place, St. Andrews, Fife.

School Laboratory Plans.

COLLEGE plans are not always safe precedents. Boys need more supervision. Can any of your readers advise as to the best arrangement of benches for a class of twenty-four to thirty boys, aged fourteen to seventeen, doing chemistry and physics with elementary quantitative experiments?

(1) Is the double back-to-back bench the best form? It may economise woodwork, but it makes the class face both ways, and attention to verbal instruction is less easy.

(2) Is the superstructure of shelving necessary? If qualitative analysis is not done, fewer bottles are needed. The superstructure hinders conversation across double benches, but it stops supervision also.

(3) What is the best way of arranging the benches so as to allow of supervision and keep wall spaces free for shelving? They may be (*a*) all round the wall, leaving no space for shelves and cupboards; or (*b*) single bench along two walls and double bench down the middle; or (*c*) across the room, double benches alternating with windows, well lighted but difficult to supervise; (*d*) central aisle with double bench extending to walls right and left; (*e*) double benches, lengthways, free from walls; (*f*) single benches, cross-ways, like the desks of an ordinary class-room.

I shall be grateful for any help or advice.

Bootham School, York, June 23. HUGH RICHARDSON.

Pair of Brazilian Marmosets Breeding in England.

A PAIR of marmosets, which for the two past winters have had a free run of our greenhouse and garden (in Buckinghamshire), produced two young ones on May 24. They seem to thrive on freedom and exercise, and the young ones are now beginning to feed themselves. In hot weather they like to remain out all night, but at first they came in to their box in the greenhouse every evening, the male parent always carrying the twins on his back, their little round furry heads merely looking like small excrescences each side of his neck; and only handing them to the mother at feeding-times, and then carefully lifting them back with both hands and settling them into position, where they seem to cling on without being held.

Their favourite garden house appears to be an old bird's nest, rather high up in a pink thorn-tree, some distance from the greenhouse. They very rarely come down to the ground, but the female will answer a call and come to feed from the hand. Bananas, milk and water, insects and young birds are the foods they like best. DORA WHITMORE.

THE DIFFRACTION PROCESS OF COLOUR-PHOTOGRAPHY.

THE production of colour by photography has been accomplished in two radically different ways up to the present time. In one, the so-called Lippmann process, the waves of light form directly in the photographic film laminæ of varying thickness, depending on the wavelength or colour of the light. These thin laminæ show interference colours in reflected light in the same way that the soap-bubble does, and these colours approximate closely to the tints of the original.

The technical difficulties involved in this process are so great that really very few satisfactory pictures have ever been made by it. The other, or three-colour process, has been developed along several distinct lines, the most satisfactory results having been produced by Ives with his stereoscopic "Krōmskōp," in which the reproduction is so perfect that, in the case of still-life subjects, it would be almost impossible to distinguish between the picture and the original seen through a slightly concave lens. The theory of the three-colour method is so well known that it will be unnecessary to devote any space to it, except to remind the reader of the two chief ways in which the synthesis of the finished picture is effected from the three negatives. We have first the triple lantern and the Kromscope in which the synthesis is optical, there being a direct addition of light to light in the compound colours, yellow being produced, for example, by the addition of red and green. The second method is illustrated by the modern trichromic printing in pigments. Here we do not have an addition of light to light, and consequently cannot produce yellow from red and green, having to produce the green by a mixture of yellow and blue. Still a third method, that of Joly, accomplishes an optical synthesis on the retina of the eye, the picture being a linear mosaic in red, green and blue, the individual lines being too fine to be distinguished as such.

The diffraction process, which I have briefly described in the April number of the *Philosophical Magazine*, is really a variation of the three-colour process, though it possesses some advantages which the other methods do not have, such as the complete elimination of coloured screens and pigments from the finished picture, and the possibility of printing one picture from another. The idea of using a diffraction grating occurred to me while endeavouring to think of some way of impressing a surface with a structure capable of sending light of a certain colour to the eye, and then superposing on this a second structure capable of sending light of another colour, without in any way interfering with the light furnished by the first structure. This cannot, of course, be done with inks, since if we print green ink over red, the result will not be a mixture of red light and green